

FORM PTO-1390 (Modified)
(REV 11/2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

70301/56942

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

10/069558

INTERNATIONAL APPLICATION NO.

PCT/EP00/07545

INTERNATIONAL FILING DATE

August 3, 2000

PRIORITY DATE CLAIMED

August 20, 1999

TITLE OF INVENTION

DEVICE AND METHOD FOR GENERATIVE MANUFACTURE OF A THREE-DIMENSIONAL OBJECT

APPLICANT(S) FOR DO/EO/US

Harald Turck, Hans Perret, Jochen Weidinger

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

First Page of WO 01/14126 A1; Verification of Translation; Form PCT/RO/101; Form PCT/IB/308; Verified Statement Claiming Small Entity Status; Recordation Cover Sheet; Certificate of Mailing

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

10/069558

INTERNATIONAL APPLICATION NO.

PCT/EP00/07545

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24. The following fees are submitted.:

CALCULATIONS PTO USE ONLY

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

- ☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040.00
- ☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

\$890.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

\$0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	25 - 20 =	5	x \$18.00
Independent claims	2 - 3 =	0	x \$84.00
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>			
TOTAL OF ABOVE CALCULATIONS =			
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.			
SUBTOTAL =			
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).			
TOTAL NATIONAL FEE =			
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input checked="" type="checkbox"/>			
TOTAL FEES ENCLOSED =			
Amount to be refunded \$			
charged \$			

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26,964

REGISTRATION NUMBER

20 Feb. '02

DATE

Attorney Docket No. 70301.56942

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: TÜRCK, Harald
PERRET, Hans
WEIDINGER, Jochen

SERIAL NO. U.S. National stage of PCT/EP00/07545

FILED: Herewith

FOR: DEVICE AND METHOD FOR GENERATIVE MANUFACTURE OF A
THREE-DIMENSIONAL OBJECT

BOX PATENT APPLICATION
COMMISSIONER FOR PATENTS
WASHINGTON, DC 20231

Sir:

PRELIMINARY AMENDMENT

Please amend the application as follows.

In the Claims:

Please cancel claims 1-25 and enter the following new claims.

--26. A device for generative manufacture of a three-dimensional object, the device comprising:

a construction area, in which the object is manufactured;
a controller;
a construction platform; and
a conveyor;

wherein the control system is structured and arranged so that it can control the execution of the following steps:

- a) manufacture of an object;
- b) removal of the manufactured object from the construction area; and
- c) repeating steps a), b) and c),

wherein at least step b) utilizes the a conveying device.

27. The device according to claim 26, wherein the control system is structured and arranged such that it controls in step a) loading the construction area with the construction platform and in step b) unloading the construction platform with the manufactured object from the construction area.

28. The device according to claim 26, further comprising:

a platform supplier, which feeds the construction platform to the conveying device; and

a platform remover device, which removes the construction platform from the device from the conveying device after the object is manufactured.

29. The device according to claim 28, wherein the platform supplier and platform remover are connected to the conveying device by a switch gear.

30. The device according to claim 26, further comprising:

a traveling actuator, which sets the position of the construction platform in the construction area; and

a connector, which connects the construction platform to the actuator.

31. The device according to claim 30, further comprising a connection final control element, which actuates the connector.

32. the device according to claim 31, wherein the connection final control element is the actuator.

33. The device according to claim 30, wherein the construction platform comprises the connector.

34. The device according to claim 26, further comprising a construction frame, which surrounds the construction platform, and which is moved together with the construction platform.

35. The device according to claim 34, further comprising:

a mounting; and

a coupler, which joins the construction frame to the mounting during loading and detaches the construction frame from the mounting during unloading.

36. The device according to claim 35, wherein the coupler comprises a coupling element, which joins the construction frame with the mounting.

37. The device according to claim 35, further comprising a coupling final control element for coupling and/or uncoupling.

38. The device according to claim 37, wherein the coupling final control element is the actuator.

39. The device according to claim 37, wherein the coupler element is biased and the coupler comprises a carrier connected to the coupling final control element, wherein the carrier can be moved by the coupling final control element to move the coupling element against the bias.

40. The device according to claim 35, wherein the coupler comprises an adjustable positioning element, with which the relative position of the construction frame to the mounting in the coupled state can be set.

41. The device according to claim 26, further comprising:
an applicator for supplying hardenable material on to the construction platform; and
a hardening device, which selectively hardens the material.

42. The device according to claim 26, wherein the device is structured and arranged such that the object can be manufactured in layers.

43. The device according to claim 26, wherein the controller is structured and arranged such that, after the manufactured object has been removed, a system maintenance of the device is carried out automatically.

44. A method for generative manufacture of a three-dimensional object with a device; the method comprising the steps of:

- a) automatically loading of the construction area of the device with a construction platform for carrying the object to be manufactured.
- b) manufacturing the object on the construction platform in a construction area;
- c) automatically removing the manufactured object from the construction area; and
- d) repeating steps a), b) and c).

45. The method according to claim 44, wherein step a) further comprises connecting the construction platform to a traveling actuator for setting the position of the construction platform in the construction area.

46. The method according to claim 44, wherein step a) further comprises automatically loading the construction platform into the construction area with a construction frame surrounding the construction platform.

47. The method according to claim 46, further comprising connecting the construction frame to a mounting of the device.

48. The method according to claim 44, wherein step b) comprises removing the construction platform together with the object manufactured on it.

49. The method according to claim 44, further comprising manufacturing the object is manufactured in layers.

50. The method according to claim 44, further comprising automatically carrying out system maintenance of the device after the manufactured object has been removed.--

REMARKS

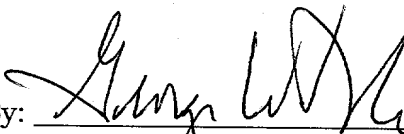
An early examination and notice of allowance are earnestly solicited. Should the Examiner wish to discuss the application, the undersigned attorney would appreciate the opportunity to do so.

Please mail all correspondence to:

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P.O. Box 9169
Boston, MA 02209

Respectfully submitted,

Date: 20 Feb 02

By: 
George W. Neuner
Registration No. 26,964

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

☒ In re application of*: 1) Harald TÜRK 2) Hans PERRET 3) Jochen WEIDINGER
Serial No.: _____ Group No.: _____
Filed: _____ Examiner: _____
For*: DEVICE AND METHOD FOR GENERATIVE MANUFACTURE OF A THREE-DIMENSIONAL OBJECT
☐ Patent No.: _____ Issued: _____

*NOTE: Insert name(s) of inventor(s) and title also for patent. Where statement is with respect to a maintenance fee payment also insert application serial number and filing date and add Box M. Fee to address.

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(c-f) and 1.27(b-d))

With respect to the invention described in
☒ the specification filed herewith.
☐ application serial no. _____, filed _____
☐ patent no. _____, issued _____

I. IDENTIFICATION OF DECLARANT AND RIGHTS AS A SMALL ENTITY

I hereby declare that I am
(complete either (a), (b), (c) or (d) below):

(a) Independent Inventor
☐ a below named independent inventor and that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code to the Patent and Trademark Office.

(b) Non-Inventor Supporting a Claim By Another
☐ making this verified statement to support a claim by _____
for a small entity status for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code and I hereby declare that I would qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under 41(a) and (b) of Title 35, United States Code, if I had made the above identified invention.

(c) Small Business Concern
☐ the owner of the small business concern identified below:
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN EOS GmbH Electro Optical Systems
ADDRESS OF CONCERN: Pasinger Straße 2
82152 Planegg/Germany and

that the above identified small business concern qualifies as a small business concern as

defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of the Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

(d) Non-Profit Organization

- ☐ an official empowered to act on behalf of the nonprofit organization identified below:

NAME OF ORGANIZATION _____

ADDRESS OF ORGANIZATION _____

TYPE OR ORGANIZATION

- ☐ UNIVERSITY OR OTHER INSTITUTION OF HIGHER EDUCATION
- ☐ TAX EXEMPT UNDER INTERNAL REVENUE SERVICE CODE (26 USC 501(a) and 501(c) (3))
- ☐ NONPROFIT SCIENTIFIC OR EDUCATIONAL UNDER STATUTE OF STATE OF THE UNITED STATES OF AMERICA
(NAME OF STATE _____)
(CITATION OF STATUTE _____)
- ☐ WOULD QUALIFY AS TAX EXEMPT UNDER INTERNAL REVENUE SERVICE CODE (26 USC 501(a) and 501(c) (3)) IF LOCATED IN THE UNITED STATES OF AMERICA
- ☐ WOULD QUALIFY AS NONPROFIT SCIENTIFIC OR EDUCATIONAL UNDER STATUTE OF STATE OF THE UNITED STATES OF AMERICA IF LOCATED IN THE UNITED STATES OF AMERICA
(NAME OF STATE _____)
(CITATION OF STATUTE _____)

and that the nonprofit organization identified above qualifies as a nonprofit organization as defined in 37 CFR 1.9(e) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code.

II. OWNERSHIP OF INVENTION BY DECLARANT

I hereby declare that rights under contract or law remain with and/or have been conveyed to the above identified

- ☐ person ☒ concern ☐ organization
(item (a) or (b) above) (item (c) above) (item (d) above)

EXCEPT, that if the rights held are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held (1) by any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if

that person had made the invention, (2) any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or (3) a non-profit organization under 37 CFR 1.9(e).

- ☒ no such person, concern, or organization
☐ person, concerns or organizations listed below*

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27).

FULL NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

III. ACKNOWLEDGEMENT OF DUTY TO NOTIFY PTO OF STATUS CHANGE

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

IV. DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

V. SIGNATURES

(complete only (e) or (f) below)

(e)

NOTE: All inventors must sign the verified statement

Name of Inventor

Signature of Inventor

Date

Name of Inventor

Signature of Inventor

Date

Name of Inventor

Signature of Inventor

Date

or

OR

(f)

NOTE: The title of the person signing on behalf of a concern or non-profit organization should be specified.

NAME OF PERSON SIGNING Johann Oberhofer
TITLE OF PERSON COO

(if signing on behalf of a concern or non-profit organization)

ADDRESS OF PERSON SIGNING Pasinger Straße 2
82152 Planegg/ Germany

SIGNATURE  DATE 11-12-01

10/069558

JC13 Rec'd PCT/PTO 20 FEB 2002

3/p.1

1

Device and method for generative manufacture of a three-dimensional object

The present invention relates to a device and a method for generative manufacture of a three-dimensional object.

A device for generative manufacture of a three-dimensional object by selective laser sintering is known, for example, from EP 0 734 842 A. There a first layer of a powdered material is applied to a base detachably connected to a lowerable carrier and irradiated at the points corresponding to the object, so the material sinters together there. Then the carrier with the base is lowered and a second layer is applied to this first layer and again selectively sintered, the second layer therein being connected to the first layer. In this way the object is formed in layers. When the formed three-dimensional object is complete, together with the base it is taken manually out of the device. This removal limits productivity, as during removal no further object can be manufactured.

The object of the invention is to provide an improved device for generative production of a three-dimensional object with which productivity can be increased and an improved method for generative production of a three-dimensional object with which productivity can be increased.

The object is achieved by the device according to claim 1 or the method according to claim 19.

Further developments of the invention are cited in the subordinate claims.

Further features and advantages of the invention emerge from the description of embodiment examples using the figures.

Fig. 1 shows a schematic sectional view of a device for manufacturing a three-dimensional object.

Fig. 2 shows a perspective illustration of the device for manufacturing a three-dimensional object.

Fig. 3 shows a sectional view of a part of the device for manufacturing a three-dimensional object from Fig. 2, in which the construction frame is coupled to the mounting.

Fig. 4 shows the sectional view according to Fig. 3, in which the construction frame is uncoupled from the mounting.

Fig. 5 shows the sectional view according to Fig. 3 without construction frame put in.

Fig. 6 shows an enlarged partial view of region A of Fig. 3.

As can best be seen from Fig. 1, the device for manufacturing a three-dimensional object has a construction frame 1, open to the top and the bottom, with circular, square or rectangular cross-section with an upper edge 2. In the construction frame a construction platform 3 is provided, connected to a vertical drive 4. The construction platform 3 can be moved up and down in the vertical direction via the vertical drive 4. On the outer edge of the construction platform 3 a seal 5 is provided, which seals the gap between the construction platform 3 and the construction frame 1. Above the upper edge

2 is arranged a hardening device in the form of a laser 6 and a deflection mirror 7. Further provided is another application device 8 for applying the material to be applied to the construction platform 3. The laser 6, the deflection mirror 7, the application device 8 and the vertical drive 4 are controlled by a control system 9. In the illustration in Fig. 1 a formed object 10 is drawn in, surrounded by non-hardened material 11. The construction frame 1 and the construction platform 3 together form a mobile container 12.

The device shown in Fig. 1 is arranged in a housing 13, shown in Fig. 2. This housing 13 has on its front face a door 14, which opens and closes automatically. In the housing 13 a construction area is provided, in which the object is manufactured. The mobile container 12 is arranged in this construction area during manufacture. Further provided is a rail system 15, connected to the housing 13, with a conveyor drive, not shown, e.g. a chain drive. With this rail system 15 an empty mobile container 12₁, 12₂ is conveyed into the device for manufacturing a three-dimensional object and a full mobile container 12₃, in other words a mobile container in which a formed object is contained, is conveyed out of the device. For this the rail system 15 has a feed section 16, a removal section 17 and a connecting section 18, connected to the device. The feed section 16, the removal section 17 and the connecting section 18 are connected to one another via switch gear 19. The feed section 16 and the removal section 17 are connected to a store, not shown, in which the empty mobile containers and the full mobile containers are kept.

As well as the rail system 15, the device contains a coupling device 20 for coupling the mobile container 12 to a mounting

13' of the housing 13 and for uncoupling the mobile container 12 from the mounting 13'. Fig. 3 shows a sectional view through the corresponding part of the mounting 13' of the housing 13, wherein a state is shown in which the mobile container 12 is coupled to the mounting 13'. As shown in Fig. 3, the construction frame 1 has in each case a projection 21, 22, projecting outwards at its lower end on both sides. On each of these projections 21, 22 an adjustable positioning element 23, 24 is provided in each case. The positioning elements 23, 24 also have in each case the effect of a stop. The length of the adjustable positioning elements 23, 24 can be set in the direction of the movement of the vertical drive 4. The mounting 13' has abutment faces 25, 26, with which the adjustable positioning elements 23, 24 are in contact in the coupled state of the mobile container 12. As can best be seen in Fig. 4, the abutment faces 25, 26 and the adjustable positioning elements 23, 24 can be constructed in such a way that in the coupled state of the mobile container 12 they engage in one another by positive locking. As can be seen from Fig. 3, the mobile container 12 is supported with its lower end on a plate 27, which is connected to the mounting 13' by springs and biased in such a way that the mobile container 12 seen in Fig. 3 is pushed upwards in such a way that the adjustable positioning elements 23, 24 are in engagement with the abutment faces 25, 26. The plate 27 is constructed in such a way that it has a recess 29 in the middle, through which the vertical drive 4 is guided. On the vertical drive 4 a carrier 30 is mounted, which, as shown in Fig. 3, is arranged above the plate 27. The carrier 30 is constructed in such a way that it is larger than the recess 29 of the plate 27. Therefore when the vertical drive 4 moves downwards the carrier 30, as shown in Fig. 4, comes into contact with the plate 27 and

takes it with it in the movement downwards against the force of the spring.

Further provided, as shown in Fig. 3, are two circulating chains 31, 32, arranged below the plate 27. On the underside of the projections 21, 22 of the construction frame 1 in each case a chain coupling element 33, 34 is mounted. The chains 31, 32 and the chain coupling elements 33, 34 are arranged with respect to one another in such a way that when the construction frame 1 moves downwards the chain coupling elements 33, 34 come into contact with the chains 31, 32, as shown in Fig. 4.

The device further has another locking device 40, as shown in Fig. 6. Fig. 6 is a detail enlargement of area A from Fig. 3, wherein the plate 27, the springs 28 and the carrier 30 are not drawn in. On the underside of the construction platform 3 a connecting piece 41 is mounted, on which a rocker arm with a first leg 43 and a second leg 44, extending perpendicular to it, is carried so as to be rotatable over the connecting area of the two legs 43, 44 at the crossing point of the longitudinal axes of the legs. The open end of the second leg 44 is rotatably connected to a locking rod 45, which is guided in a guide 46 in such a way that the locking rod 45 in the inserted state of the mobile container 12 can be moved forwards and backwards only perpendicular to the direction of movement of the vertical drive 4, as indicated by the double arrow A in Fig. 6. The guide 46 is connected to the construction platform via a connecting element, not shown. The front end 47 of the locking rod 45, pointing away from the open end of the second leg 44, is constructed as tapering. An annular recess 48, formed corresponding to the front end 47 is

provided on the vertical drive 4. A rotatably carried roller 49 is provided at the open end of the first leg 43 of the rocker arm 42. In the position of the construction platform 3 shown in Fig. 6 the roller 49 is in contact with an unlocking projection 50 of the construction frame 1. Between the rocker arm 42 and the connecting piece 41 is arranged a torsion spring 41, which biases the rocker arm in such a way that the locking rod 45 is moved towards the vertical drive 4. The rocker arm 42, the unlocking projection 50 and the locking rod 45 are arranged in such a way that on further movement of the vertical drive 4 downwards in the state shown in Fig. 6 the unlocking projection 50 presses the first leg 43 of the rocker arm 42 via the roller 49 upwards against the force of the spring of the torsion spring 51, so the locking rod 45 in Fig. 6 is moved to the left, whereby the engagement of the front end 47 with the recess 48 is released.

The operation of the device will now be described. It is therein assumed that a construction platform 3 and a construction frame 1 are already contained in the device or in the construction area. First the construction platform 3 is positioned in the construction frame 1 in such a way that it is positioned below the upper edge 2 of the construction frame 1 by a predetermined layer thickness. Then by means of the application device 8 a layer of the material to be hardened is applied to the construction platform 3 and then selectively hardened at the desired places with the hardening device. After that the construction platform is lowered by a desired layer thickness and a further layer of material is applied. This is again selectively hardened and therein connected to the lower layer of material. This is continued until the object to be manufactured is complete. Several objects in

succession and/or on top of one another on the construction platform 3 can also be manufactured in a construction process of the sort described. Then the construction platform 3 is moved into the position shown in Fig. 3. The control system 9 controls the vertical drive 4 further in such a way that it travels from the position shown in Fig. 3 further downwards. In this way the carrier 30 comes into contact with the plate 27 and takes it with it when the vertical drive moves downwards against the force of the spring of the springs 28. In this way the mobile container 12, which is located on the plate 27, is also moved downwards. Thus the engagement between the adjustable positioning elements 23, 24 and the abutment faces 25, 26 is released. This movement of the vertical drive 4 downwards is continued until the chain coupling elements 33, 34 reach engagement with the chains 31, 32, as shown in Fig. 4. Simultaneously by this movement of the vertical drive 4 downwards the first leg 43 of the rocker arm 42 is pressed against the unlocking projection 50 of the construction frame 1, shown in Fig. 6, whereby the first leg 43 is moved towards the construction platform. In this way the locking rod 45 seen in Fig. 6 is moved to the left and the engagement between the front end 47 of the locking rod 45 and the recess 48 is released. Therefore the construction frame 1 is uncoupled from the mounting 13' and the construction platform 3 separated from the vertical drive 4. Now by means of the control system 9 the automatic door 14 (Fig. 2) is opened and the chains 31, 32 triggered, whereby the full mobile container 12 is conveyed out of the device (Fig. 5). The switch gear 19 has previously been set in such a way that the full mobile container 12 is conveyed to the removal section 17. From there the full mobile container 12 is conveyed to the store. After that the switch gear 19 is re-set in such a way that the feed section 16 is

connected to the connecting section 18. Via this connection an empty mobile container 12₁ is now conveyed into the machine. The vertical drive 4 is now moved upwards by the control system 9. In this way in reverse order the empty mobile container 12₁ is coupled to the mounting 13' of the housing 13, as shown in Fig. 3, and the construction platform 3 is locked to the vertical drive 4, as shown in Fig. 6. The control system 9 now carries out all the activities necessary for starting a new construction process. This comprises, for example, providing the geometrical data for the object to be manufactured and checking the state of the device. This checking comprises, for example, a check of whether there is still sufficient material in the device and checking the hardening device. Based on the result of this checking, for example topping up material from an external storage vessel, cleaning the hardening device and/or carrying out a calibration of the hardening device are controlled by the control system 9. After that the control system 9 starts a new construction process and a new object is now formed on the construction platform 3 of the empty mobile container 12₁. The steps described are all carried out automatically by means of the control system 9.

One advantage of this embodiment is that coupling and uncoupling of the construction frame 1 to the mounting 13' of the housing 13 is carried out by the movement of the vertical drive 4. This saves having an additional actuator. Furthermore, the actuating force for the locking of construction platform 3 and vertical drive 4 is also derived from the movement of the vertical drive 4. A solution of this kind has the advantage, in view of the raised temperatures occurring in this area of the construction frame, typically

between 100 and 150°, when certain materials are used, such as e.g. synthetic powder, that no actuator is subjected to these temperatures. In addition there is no need for sensors or switches, which promotes simplicity and therefore reliability.

In an alternative embodiment it is possible to generate the lifting movement required for coupling the construction frame 1 to the mounting 13' of the housing 13 and for locking the construction platform 3 to the vertical drive 4 by an additional actuator. An additional actuator can also be provided in each case for each of these movements.

In a further development of the invention the housing 13 of the device bordering on the front side has a further door on one of the side walls or on the back. The rail system is then connected to this door and provided either at the side of or behind the machine. This has the advantage that the machine can be loaded manually through the door 14 on the front face and automatically via the rail system via the side or rear door. Also in a further development the control system is constructed in such a way that after the manufactured object has been removed system maintenance of the device, comprising, for example, cleaning the blades of the application device, cleaning the optics of the laser system and/or re-calibration, is carried out automatically.

A device and a method have been described in which the object is manufactured in layers by means of controlled action of a laser beam at points in each layer corresponding to the cross-section of the object. Devices and methods of this kind are, for example, a laser sintering device or a stereolithography device and the associated methods. The invention is not,

however, restricted to these. Any device and any method can be provided in which the object to be manufactured is formed generatively, i.e. the object is formed by controlled adding of construction material. For example, a device can also be provided in which an object is manufactured by hardening in layers of a powdered material by means of an adhesive.

A decisive point of the present invention is that the control system 9 controls the manufacture of one or more objects, the unloading of this or these object(s) from the construction area of the device, the execution of the activities for a further construction process, forming one or more further objects, the unloading of this or these object(s), etc. in such a way that this is carried out fully automatically. In this way a fully automatic sequence of several construction processes is enabled by generative manufacturing methods. Furthermore, no manual activities are required and the productivity of the device or the method is increased.

In the embodiments described loading the construction area of the device with an empty mobile container 12₁, 12₂, forming the object and unloading from the mobile container 12₃ with the object formed therein from the construction area is controlled in such a way that it is carried out automatically. It is also possible, however, for only the construction platform 3 to be replaced automatically. This is particularly the case with the kind of devices for generative manufacture or manufacture in layers of a three-dimensional object which have a construction frame rigidly connected to the machine or which have no construction frame. A device without construction frame is, for example, a device for the FDM method (FDM = fused deposition modelling), described for example in US 5 121 329.

Furthermore, in a further embodiment it is also possible that only the manufactured object is unloaded from the construction area of the device and afterwards a further object is manufactured which is again unloaded.

Furthermore, on removal from the construction area the manufactured objects can be put into a different area of the device and later removed manually or automatically from the device.

Claims

1. Device for generative manufacture of a three-dimensional object, with
a construction area, in which the object is manufactured
and a control system (9) which is constructed in such a way that it can control the execution of the following steps:
 - a) manufacture of an object,
 - b) removal of the manufactured object from the construction area,
 - c) repeating steps a) and b), characterised by a conveying device (18, 31, 32) for unloading and loading the construction area with a construction platform (3) for carrying the object to be manufactured.
2. Device according to claim 1, wherein the control system is constructed in such a way that it can control in step
a) loading the construction area with the construction platform (3) and in step b) unloading the construction platform (3) with the manufactured object from the construction area.
3. Device according to claim 1 or 2, further with a feed device (16) for feeding the construction platform (3) to be loaded into the device to the conveying device (18, 31, 32)
and a removal device (17) for removing a construction platform (3) to be unloaded from the device from the conveying device (18, 31, 32).

4. Device according to claim 3, in which the feed and removal devices (16, 17) are connected to the conveying device (18, 31, 32) via switch gear (19).
5. Device according to one of claims 1 to 4, further with a travelling actuating element (4) for setting the position of the construction platform (3) in the construction area and a connecting device (40) for connecting the construction platform (3) to the actuating element (4).
6. Device according to claim 5, with a connection final control element for actuating the connecting device (40).
7. Device according to claim 6, in which the connection final control element (40) is the actuating element (4).
8. Device according to one of claims 5 to 7, in which the connecting device (40) is provided on the construction platform (3).
9. Device according to one of claims 1 to 8, in which a construction frame (1) surrounding the construction platform (3) is provided, which is loaded and unloaded into or from the construction area together with the construction platform (3).
10. Device according to claim 9, further with a mounting (13') and a coupling device (20) for coupling the construction frame (1) to the mounting (13') during loading and for uncoupling the construction frame (1) from the mounting (13') during unloading.

11. Device according to claim 10, in which the coupling device (20) has a coupling element (27) which brings the construction frame (1) in the coupled state into connection with the mounting (13').
12. Device according to claim 10 or 11, further with a coupling final control element for coupling and/or uncoupling.
13. Device according to claim 12, in which the coupling final control element is the actuating element (4) for setting the position of the construction platform (3) in the construction area.
14. Device according to claim 12 or 13, in which the coupling element (27) is biased and the coupling device (20) has a carrier (30) connected to the coupling final control element, which can be moved by the coupling final control element in such a way that it moves the coupling element (27) against the bias.
15. Device according to one of claims 10 to 14, in which the coupling device has an adjustable positioning element (23, 24), with which the relative position of the construction frame (1) to the mounting (13') in the coupled state can be set.
16. Device according to one of claims 1 to 15, further with an application device (8) for applying hardenable material on to the construction platform (3) and a hardening device (6, 7) for the selective hardening of the applied material.

17. Device according to one of claims 1 to 16, wherein the device is constructed in such a way that the object can be manufactured in layers.
18. Device according to one of claims 1 to 17, wherein the control system is constructed in such a way that after the manufactured object has been removed system maintenance of the device is carried out automatically.
19. Method for generative manufacture of a three-dimensional object with a device with the steps:
 - a) manufacture of an object in a construction area of the device,
 - b) removal of the manufactured object from the construction area and
 - c) repeating steps a) and b),
wherein steps a) to c) are carried out automatically, characterised in that before each step a) the following step d) is carried out:
 - d) automatic loading of the construction area with a construction platform (3) for carrying the object to be constructed.
20. Method according to claim 19, in which in step d) the construction platform (3) is connected to a travelling actuating element (4) for setting the position of the construction platform (3) in the construction area.
21. Method according to claim 19 or 20, in which in step d) the construction area is automatically loaded with the

construction platform (3) and with a construction frame (1) surrounding the construction platform (3).

22. Method according to claim 21, in which in step d) the construction frame (1) is connected to a mounting (13') of the device.
23. Method according to one of claims 19 to 22, in which in step b) the construction platform (3) is removed together with the object manufactured on it.
24. Method according to one of claims 19 to 23, in which the object is manufactured in layers.
25. Method according to one of claims 19 to 24, wherein after the manufactured object has been removed system maintenance of the device is carried out automatically.

Abstract

A device and a method for generative manufacture of a three-dimensional object are provided in which

- a) manufacture of an object in a construction area of the device,
- b) removal of the manufactured object from the construction area and
- c) repeating steps a) and b) are carried out, wherein steps a) to c) are carried out automatically.

(Fig. 3)

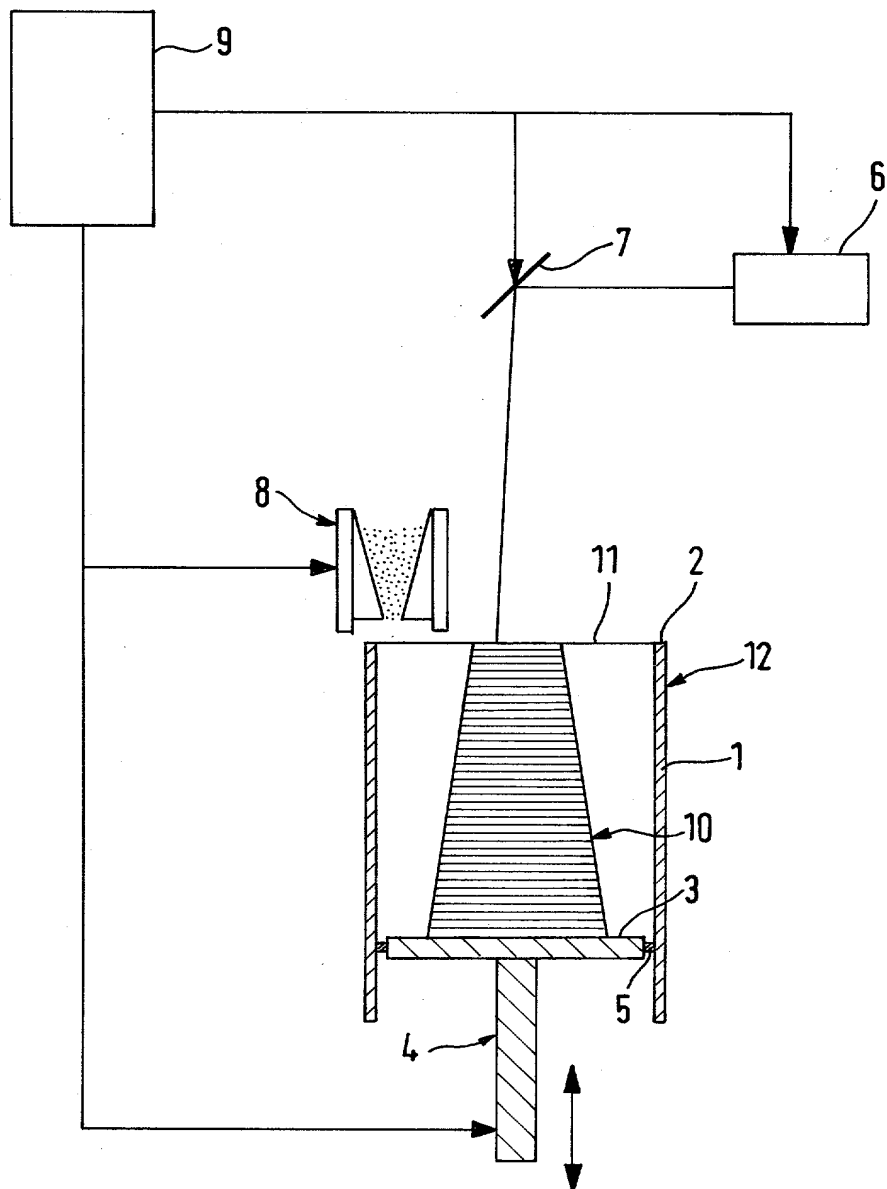


FIG. 1

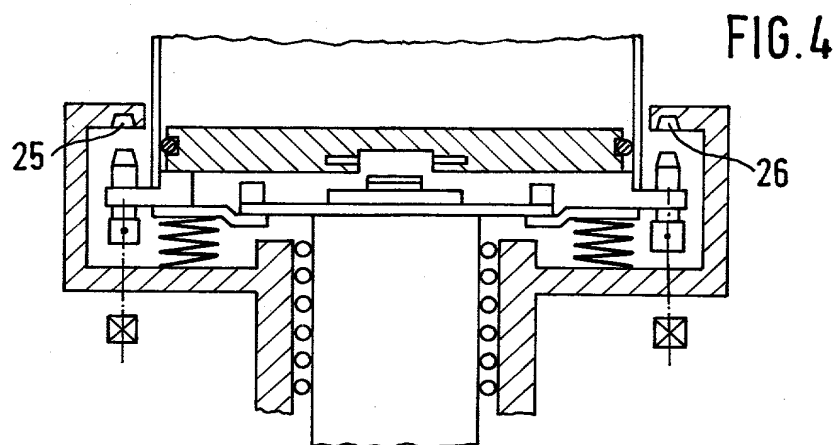
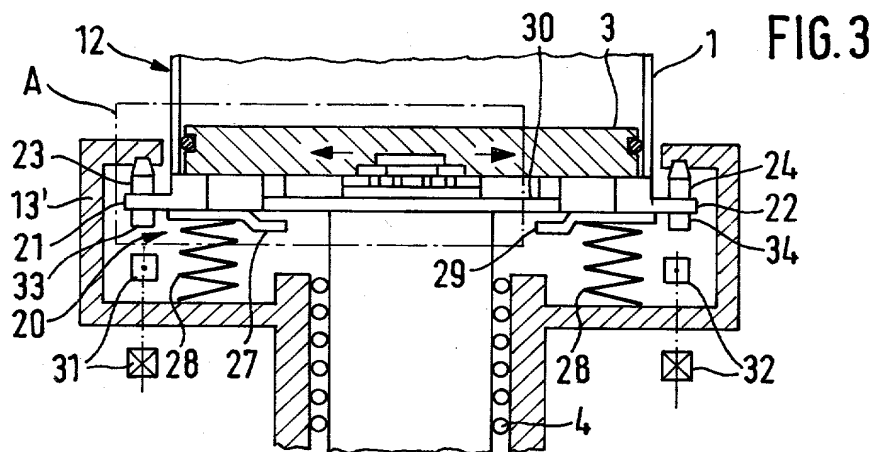
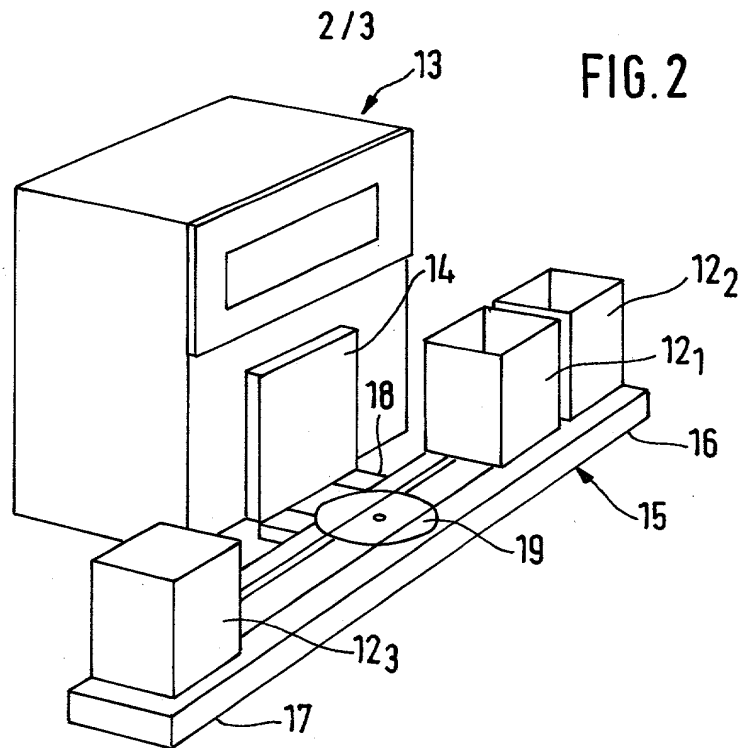


FIG. 5

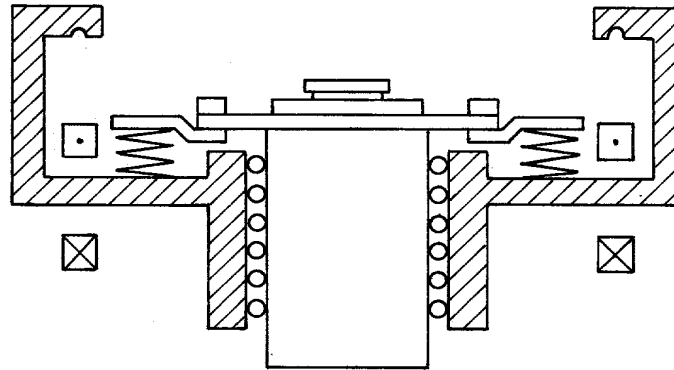
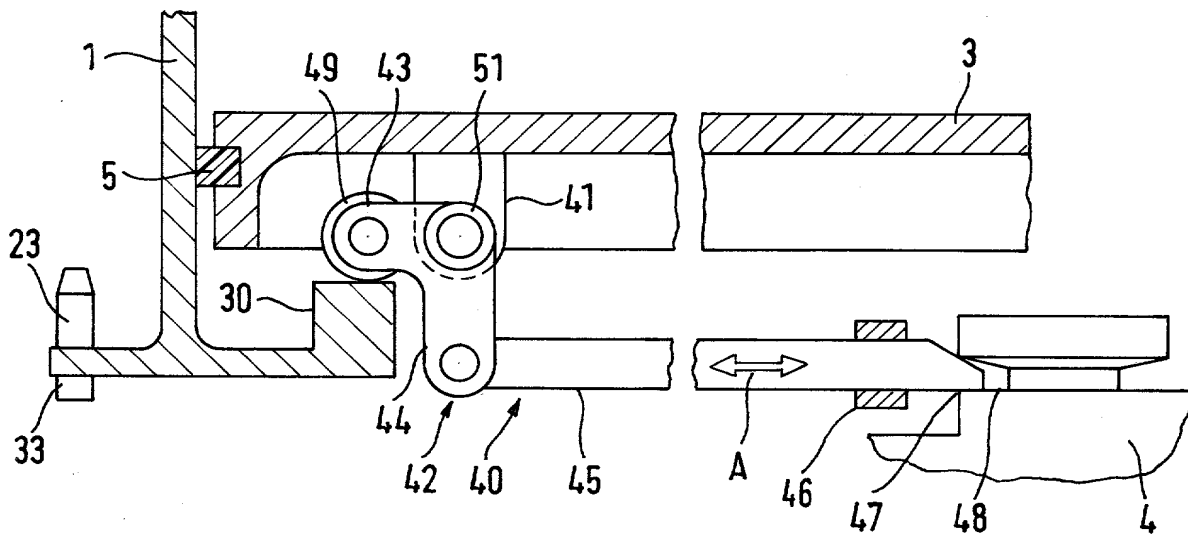


FIG. 6



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DECLARATION
AND POWER OF ATTORNEY
Original Application

EXPRESS MAIL NO. EL789783036 US
ATTORNEY'S DOCKET NO: (If Any)
70301/56942

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed at 201 below) or an original, first and joint inventor (if plural names are listed at 201-203 below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DEVICE AND METHOD FOR GENERATIVE MANUFACTURE OF A THREE-DIMENSIONAL OBJECT

which is described and claimed in:

☒ the attached specification or

☐ the specification in application Serial No. filed
(for declaration not accompanying application)

And was amended on
if applicable

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

FOREIGN APPLICATION(S), IF ANY, FILED WITHIN 12 MONTHS PRIOR TO THE FILING DATE OF THIS APPLICATION			
COUNTRY	APPLICATION	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
XXXXXX	199X30X616X7	20X08X1999	XXX XXX
			YES NO
ALL FOREIGN APPLICATIONS, IF ANY, FILED MORE THAN 12 MONTHS PRIOR TO THE FILING DATE OF THIS APPLICATION			
Germany	199 39 616.7	20/08/1999	
PCT	PCT/EP00/07545	03/08/2000	

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (Patented, pending, abandoned)

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I hereby further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE OF INVENTOR 201 <u>Harald Turck</u>	SIGNATURE OF INVENTOR 202 <u>Hans Perret</u>	SIGNATURE OF INVENTOR 203 <u>Jochen Weidinger</u>
DATE <u>JANUARY 10, 2000</u>	DATE <u>DEC. 10/2000</u>	DATE <u>DEC. 10/2000</u>